

Does the CAMELS bank ratings system follow a procyclical pattern?

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Abstract

The financial crisis which erupted in 2007-8 has illustrated the disruptive effects of procyclicality. The phenomenon of procyclicality refers to the mutually reinforcing interactions between the financial system and the real economy that tend to amplify business cycle fluctuations. In this study, we empirically investigate the sensitivity of the CAMELS ratings system, which is used by the U.S. authorities to monitor the conditions in the banking market, to the fluctuations of the economic cycle. Our results suggest that the overall state of the U.S. economy and bank regulatory ratings are positively linked to each other: CAMELS increase during economic upturns and decrease during downturns. This is to say that the performance and risk-taking behaviour of banks is rated higher when the conditions in the economy are favourable and lower when the economic environment is weak. Along these lines, we document a positive relationship between CAMELS and the conditions in financial markets. This very important and rather unknown source of procyclicality should be taken into serious consideration by authorities.

Keywords: bank regulation; CAMELS ratings; procyclicality, financial crisis.

JEL classification: C13; C20; C50 ; D02; G21; G28

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1. Introduction

The concern about procyclicality has been revived after the eruption of the global financial crisis in 2007-8. In broad terms, procyclicality is related to the mutually reinforcing interactions between the financial system and the real economy that tend to amplify business cycle fluctuations. These fluctuations can cause or exacerbate turbulences in the financial system and this explains why supervisory and regulatory authorities are so much concerned in mitigating the degree of procyclicality of the system.

The key sources of procyclicality in the financial sector are related to the distortions in incentives. To provide an example, financial contracts that establish a direct link between asset valuations and funding do not capture the conflicts of interest between lenders and borrowers. A second example of incentives' distortions involves actions by individual agents that may be rational from the agents' perspective, but may result in unfavourable outcomes for the system as a whole. This happens when, e.g., bank managers take excessive risk with the purpose to increase the short-term profits of their banks and also their bonuses. Excessive risk, however, has been proved to be harmful for the stability of the financial system and detrimental for the entire economy in the medium to long-run.

The procyclical tendency of the financial systems worldwide towards boom-bust cycles goes back to the work of Minsky (1977). Nevertheless, the impact of procyclicality on the smooth functioning of the economic and financial activities had only recently confirmed in the relevant empirical literature. Indeed, bank capital adequacy requirements, risk and profit measurements, and credit supply have all been lately found to be amongst the fundamental factors which foster the positive feedback mechanisms between the financial and the real sectors of the economy. Moreover, some recent studies have provided strong support to the view that the lending behaviour of banks is significantly affected by business cycle waves. Along the same lines, bank leverage has been also lately found to follow a procyclical pattern.

Even though the banking literature on procyclicality has sufficiently advanced over the last decade or so, little attention has been paid on the ratings of banking institutions and how these are linked to the phenomenon of procyclicality. In this paper, we make an effort to fill this literature gap by examining the sensitivity of the CAMELS ratings system to the fluctuations of economic cycle. The Uniform Financial Rating System, informally known as CAMELS ratings system, is one of the most important tools that the U.S. regulatory authorities use to assess the

overall health of individual banking institutions and to monitor the conditions in the banking market. In fact, regulators resort to CAMELS every 12 to 18 months to conduct on-site examinations of bank safety and soundness. Our results suggest that the overall state of the U.S. economy and bank regulatory ratings are positively linked to each other: CAMELS increase during economic upturns and decrease during downturns. This is to say that the performance and risk-taking behaviour of banks is rated higher when the conditions in the economy are favourable and lower when the economic environment is weak. Along these lines, we document a positive relationship between CAMELS and the conditions in financial markets.

The structure of the paper is as follows. Section 2 reviews the relevant literature. Section 3 presents the data set, the variables, and the econometric model which we employ in our analysis; the empirical results are discussed in this Section. Section 4 is devoted to robustness checks, whereas Section 5 provides a brief summary of our main findings and offers some concluding remarks.

2. Literature review

Early research on procyclicality has been mainly focused on the operation of bank capital buffers in the context of Basel I (Rime, 2001; Ayuso et al., 2004; Estrella, 2004; Lindquist, 2004; and Jokopii and Milne, 2006 among others). Though the majority of these studies focus on different banking markets and rely on various econometric techniques, they all provide strong empirical evidence that the Basel I capital buffers exhibit significant cyclical patterns in the sense that buffers tend to increase during economic downturns and decrease during upturns. Several other studies have evaluated the cyclicity character of capital charges under Basel II before its implementation by employing numerical simulations on hypothetical or real world portfolios. For example, Kashyap and Stein (2004) conduct a simulation exercise to show that the increase in capital charges under Basel II for the average virtual portfolio of borrowers lies in the range of 30% to 45%. In a similar vein, Jokivuolle and Peura (2004) and Zicchino (2005) find that capital buffers dampen the cyclical effects of Basel II. Repullo and Suarez (2013) construct a dynamic general equilibrium model that highlights the cyclical behaviour of the Basel II capital buffers. They show that the probabilities of bank failures are much lower under the Basel II regime than under Basel I or in a situation with no capital requirements. This is to say, the side effects of

Basel II are basically consist of a pay-off in terms of the long-term solvency of banking organisations.

After the onset of the late 2000s crisis, the relevant literature has documented that during boom phases where the financial sector rises and economy grows, banks are very optimistic regarding near future economic trends (*i.e.*, a general euphoria prevails in the economy) thus utilising downward biased information sets to evaluate risk. As a consequence, risk tends to be underestimated making the (risk-based) Basel II capital requirements to shrink in the expansion phase of the business cycle when risk is measured to be low. At the same time, banks expand their lending activity which, in turn, inflates asset prices. Collateral values also rise justifying even more lending and this perpetuates the endogenous cycle. The opposite with what we describe above occurs in economic downturns like in the period that followed the years 2007-8. On the one hand, banks are particularly fragile in this phase of the business cycle which renders them very cautious in extending credit, whereas on the other hand market expectations on future economic activity and future economic fundamentals are very low. Hence, in such periods, risk is measured to be high feeding further the inclination of financial institutions to strengthen their capital base by holding capital well in excess of the minimum requirements. The increase in capital requirements during downswings reduces credit availability and asset prices and is highly likely to result in a credit crunch that deteriorates the already adverse economic conditions.

To move further, Gordy and Howells (2006) examine the phenomenon of procyclicality by focusing on the Third Pillar of Basel II, which concerns market discipline via public disclosure practices. Their study investigates whether and to what extent the enforcement of banks to disclose detailed information on their risk profile and capital adequacy to the public has a procyclical impact on banks' lending activity. Their simulation-based empirical approach indicates that the extent of cyclicity in capital requirements depends largely on how market discipline makes banks to vary their fresh loans according to macroeconomic conditions. By the same token, Peek et al. (2003) and Lown and Morgan (2006) show that the supply of credit increases during cycle upturns and shrinks in contraction phases.

The debate over the procyclicality of the financial system has also turned to focus on the impact that the loan loss provisioning system of banking institutions has on credit cycles. There are two different aspects for such kind of analysis depending on how Loan Loss Provisions (LLPs) are treated. On the one hand, we have the so-called 'risk-management hypothesis' that

emphasises the interest of regulatory and supervisory authorities to reduce procyclicality of both LLPs and bank capital. Risk management links provisioning rules to the capital requirements through the coverage of credit risk. Specifically, expected future credit losses are covered by loan loss reserves whereas unexpected losses are covered by capital reserves. The component of LLPs which covers expected losses is called non-discretionary. There is, however, one more component, the discretionary component, which is linked to the ‘capital management hypothesis’ according to which provisions are used for bank management purposes like income smoothing, capital management, or for the signaling of bank financial strength to investors and their counterparts.

Bouvatier and Lepetit (2008) use a sample of 184 European banks over the period 1992-2004 to examine how LLPs affect the procyclicality of the financial system by differentiating the discretionary component of LLPs from the non-discretionary component. They conclude that the former one has no considerable impact on credit cycles, in contrast to the latter one which amplifies system’s procyclicality. In more details, their results show that banks are capable of identifying only a small number of problem loans in periods of economic upsurges, whereas provisions for bad loans increase by a lot when economy slows down. The procyclical effect of the non-discretionary component of LLPs is also reported in the studies of Laeven and Majnoni (2003) and Bikker and Metzmakers (2005) and, more recently, in that of Fonseca and Gonzalez (2008).

Albertazzi and Cambacorta (2009) empirically examine the relationship between bank profitability and business cycle fluctuations focusing on a set of 10 industrialised economies. Profits are calculated using interest and non-interest income together with operating expenses, and LLPs. Their findings suggest that interest income and provisions are strongly affected by changes in economic growth in contrast to noninterest income which remains rather unaltered. Since banks rely more and more on modern financial products that produce noninterest income, they argue that bank profits have turned to be less procyclical nowadays.

Another aspect of procyclicality is the one related to the leverage of financial institutions. Adrian and Shin (2010) investigate the leverage behaviour of the five largest US investment banks prior to the crisis finding strong evidence of procyclicality. They show that in the economic upsurge that preceded the crisis, the market value of assets moved upwards and investment banks exploited this trend to increase their leverage. Such increase was attained

mainly through the increase in overnight inexpensive repurchase agreements. Notwithstanding the fact that the procyclicality of leverage can be more pronounced for non-depository institutions like investment banks whose assets and liabilities are more exposed to market conditions, the reliance of commercial banks on short-term funding through securitised activities made the typical retail depository institutions also prone to procyclicality. In fact, IMF World Economic Outlook (2008) provides strong evidence of procyclical leverage by commercial banks in arm's-length financial systems, *i.e.*, systems where intermediation relies more on financial markets and not so much on traditional bank-based activities.

Procyclicality can also be traced in the credit rating scores assigned to financial institutions by the international rating agencies. Indeed, Pagratis and Stringa (2009) provide significant evidence of a positive relationship between bank ratings and economic activity. Following the relevant corporate finance literature (see, e.g., Amato and Furfine, 2004) and using a sample of 293 banks from 33 countries over the period 1999-2006, they show that senior unsecured ratings assigned to banks by Moody's tend to be lower in economic slowdowns and higher in economic upturns.

3. Empirical analysis

3.1. Data set

We focus on U.S. commercial and savings banking institutions that file a Report on Condition and Income (also known as Call Report). Thrifts -*i.e.*, savings and loans associations- are excluded from our empirical analysis because they file a different report (the Thrift Financial Report).¹ Data are of quarterly frequency and extend from the beginning of 2002 (2002q1) to the end of 2015 (2015q4) thus capturing both the pre- and the post-crisis periods. Since our focus is on the global financial crisis, we do not examine the years prior to 2002 because the two international financial crises which erupted in East Asia and in Russia towards the end of the '90s combined with the Long Term Capital Management (LTCM) crisis in late 1998 and the dot-com bubble crisis of the early 2000s all had a considerable destabilising impact on the operation of international financial markets and on the U.S. banking system.

¹ With the implementation of the Dodd-Frank Act and the establishment of the Office of Thrift Supervision in July 2011, all thrifts were required to file and submit a Call Report from March 2012.

We begin with 8,905 active commercial and savings banking institutions that filed a Call Report in 2002q1. Due to failures, mergers and acquisitions (M&As) that took place during the sample period, the total number of active banks was reduced to 6,791 in 2015q4. After checking the data for reporting errors and other inconsistencies, we end up with a total of 6,509 banks.

3.2. The CAMEL ratings system

The Uniform Financial Rating System, informally known as CAMEL, was introduced by the U.S. regulators in November 1979 to conduct on-site examinations of bank safety and soundness. CAMEL is a vector of five different measures capturing Capital adequacy, Asset quality, Management expertise, Earnings strength, and Liquidity. In 1996, CAMEL evolved into CAMELS, with the addition of a sixth component ('S') that summarises the Sensitivity to market risk. Under the CAMELS rating system, banking firms are rated from 1 (best) to 5 (worst). Banks with a composite rating of 4 or 5 are considered problem banks. Banks with ratings of 1 or 2 are considered to present few, if any, supervisory concerns, while banks with ratings of 3, 4, or 5 present moderate to extreme degrees of supervisory concern.

The dependent variable in our model is denoted by *CAMELS* and is a composite vector of Capital adequacy, Asset quality, Management expertise, Earnings strength, Liquidity, and Sensitivity to market risk. We follow the relevant literature (see, e.g., Lane et al, 1986; Cole and Gunther, 1995; Stojanovic et al., 2008; Ioannidis et al., 2010; Klomp and de Haan, 2012) to construct a vector of bank performance and risk-taking measures, which is designed to resemble the original CAMELS components. We use the standard equity-to-assets ratio as an indicator of bank capital strength (*CAP1*); asset quality is measured by the ratio of non-performing loans to total loans and leases (*ASSETQLT1*); the quality of bank management is measured by managerial efficiency as calculated by the input-oriented Data Envelopment Analysis (*MNGEXP1*);² the return on assets expressed as the ratio of total net income (given by the difference between total interest plus non-interest income and total interest plus non-interest expense) to total assets is applied as a measure of earnings strength (*EARN1*); the ratio of cash and balances due from depository institutions to total deposits reflects the degree of bank liquidity (*LQDT1*); lastly, sensitivity to market risk (*SENSRISK1*) is proxied by the change in the slope of the yield curve

² The calculation of *MNGEXP1* is described in Appendix B.

(given by the change in the quarterly difference between the 10-year U.S. T-bill rate and the 3-month U.S. T-bill rate) divided by total earning assets.

To develop all the aforementioned ratios, we use bank balance sheet data of quarterly frequency which are collected from Call Reports as found in the website of the Federal Reserve Bank of Chicago and that of the Federal Financial Institutions Examination Council (FFIEC) Central Data Repository's Public Data Distribution. Interest rates and yields are collected from the Federal Reserve Board and the U.S. Department of the Treasury and are also of quarterly frequency. All variables and the relevant data sources are summarised in Appendix A.

3.3. The econometric model

The model we employ in our empirical analysis relies on a data set which, as earlier described, consists of the universe of the U.S. commercial and savings banks and extends from 2002q1 to 2015q4, where $q=2002q1, 2002q2, \dots, 2015q4$. Our model is as follows:

$$\begin{aligned} CAMELS_{it} = & \alpha_{it} + \beta_{1,t}GDP_t + \beta_{2,t}CPI_t + \beta_{3,t}UNEM_t + \beta_{4,t}VIX_t + \beta_{5,t}MRKLQDT_t \\ & + \beta_{6,t}MRKCREDIT_t + \gamma_{1,it}SIZE_{it} + \gamma_{2,it}MA_{it} + \gamma_{3,it}MSA_{it} + \gamma_{4,it}DENOVO_{it} + \\ & + \gamma_{5,it}PUBLIC_{it} + \gamma_{6,it}BHC_{it} + \gamma_{7,t}HHI_t + \gamma_{8,t}CR1_t + \varepsilon_{it} \end{aligned} \quad (1)$$

where $i=1, 2, \dots, N$ ($N=6,509$) sample banks, and $t=1, 2, \dots, T$ ($T=56$) quarters. We measure the main economic fundamentals with the following three variables: the GDP output gap (GDP) as obtained from the Bureau of Economic Analysis of the U.S. Department of Commerce; the change in the U.S. Consumer Price Index (CPI) to control for variations in the level of prices; and the unemployment rate ($UNEM$). Both inflation and unemployment data are obtained from the Bureau of Labor Statistics of the U.S. Department of Labor. We also account for the financial state variables that are expected to affect bank ratings as captured by *CAMELS*. We measure market return volatility with the Implied Volatility Index (VIX) obtained from the Chicago Board Options Exchange Market, the market liquidity risk ($MRKLQDT$) given by the quarterly difference between the 3-month LIBOR rate and the 3-month U.S. T-bill rate, and the market credit risk ($MRKCREDIT$) measured by the quarterly change in the credit spread between the 10-year BAA-rated bonds and the 10-year U.S. T-bill rate. The latter two variables are constructed based on data from the Federal Reserve Board, GFDatabase, and Moody's.

Turning to the control variables of our model, we introduce bank size (*SIZE*) as the logarithm of the book value of total assets. Moreover, a number of banks played the role of acquirers in the M&A deals that took place during the examined period but, mainly, after the outbreak of the crisis. We, therefore, resort to the relevant files of the Federal Reserve Bank of Chicago to investigate whether a bank has been involved in a M&A transaction as an acquirer to control for the effect on our dependent variable.³ Towards this, we introduce a dummy variable in our model (*MA*), which is equal to unity when the acquirer bank *i* is involved in a M&A transaction and remains equal to one until the end of our data period. For example, if an acquisition occurred on April 15 2008 then this transaction is recorded in the second quarter of 2008, meaning that the binary variable *MA* takes the value of one in 2008q2 and remains as such for all the subsequent quarters.

We follow Jordan et al. (2011) and Berger and Roman (2015) and introduce a dummy indicator (*MSA*) which is equal to one if a bank is located in a Metropolitan Statistical Area -an integrated economic and social unit with a recognised large population nucleus- and zero otherwise. The geographical location of each sample bank is identified through Call Reports; detailed data for the Metropolitan Statistical Areas are taken from the U.S. Office of Management and Budget.

It is well-documented in the banking literature that the behaviour and performance of the newly chartered banks substantially differ from those of banks in operation over a relatively long period of time. More specifically, once a bank first enters the market, its financial performance tends to lag by a considerable margin compared to that of the existing banking firms.⁴ That said, we account for the so-called *de novo* banks, defined as banks less than five years old by including a dummy (*DENovo*) in our model.

We follow Berger and Roman (2015) and construct an indicator variable (*PUBLIC*) that captures if a bank is listed on the stock exchange. Since the decision-making units we examine are not holding companies, the subsidiaries of publicly traded BHCs are considered to be public. Banks with private placements of shares with a Committee on Uniform Securities Identification Procedures (CUSIP) number, banks without a stock exchange listing, and banks whose bank

³ The relevant data can be found in the following web page: <https://www.chicagofed.org/banking/financial-institution-reports/merger-data>

⁴ See, e.g., DeYoung and Hasan (1998), and DeYoung (2003) for a thorough analysis on the operational behaviour of *de novo* banks.

holding company is not listed at the stock exchange are treated as non-public. The data on trading and listing are derived from the Center for Research in Security Prices (CRSP) database. Lastly, a dummy variable (*BHC*) showing whether a sample bank is a subsidiary of a BHC is also considered in our empirical analysis as in Jordan et al. (2011) and Berger and Roman (2015).

Moreover, we measure the degree of market concentration with the Herfindahl-Hirschman Index (*HHI*) using bank total deposits as the input variable. *HHI* is calculated as the sum of squares of the market share of each bank included in our sample:

$$HHI_t = \sum_{i=1}^n (\text{market share})_{iq}^2 \quad (2)$$

Eq. (2) relies on the market share of bank *i* at quarter *q* where *n* is the total number of banks in the examined market. The index ranges from 0 to 10,000, where zero reveals a market with an infinite number of banks and 10,000 shows a market with just a single banking firm. *HHI* is a static measure in the sense that it estimates market concentration at some particular point in time *q*.

We further introduce a crisis dummy (*CRI*) to capture the impact of crisis on the operation of the banking firms. We consider the third quarter of 2007 (2007q3) to be the starting point of the crisis. Indeed, that was the time when the TED spread (the difference between the yield on the three-month London Interbank Offered Rate -i.e., LIBOR- and the yield on three-month U.S. Treasury bills) which is one of the most widely-used indicators of credit risk, widened to almost 200 basis points relative to a historically stable range of 10-50 basis points.⁵ All variables we employ in eq. 1 and the sources utilised to construct them are summarised in Appendix A.

3.4. Discussion of the empirical results

The regression results of our baseline analysis are presented in the Table 1 that follows.

⁵ Other recent studies -like that of Cornett et al. (2011)- also use the third quarter of 2007 as the starting point of the crisis.

Table 1
Estimation results: Baseline model

<i>Variable</i>	Coeff. value	<i>t</i> -stat
<i>GDP</i>	0.17	3.35***
<i>CPI</i>	0.19	2.98***
<i>UNEM</i>	-0.11	-2.65***
<i>VIX</i>	-0.16	-4.15***
<i>MRKLQDT</i>	-0.19	-2.19**
<i>MRKCREDIT</i>	-0.09	-2.01**
<i>SIZE</i>	0.38	2.21**
<i>MA</i>	0.22	2.38**
<i>MSA</i>	0.04	1.99**
<i>DENOVO</i>	-0.15	-1.76*
<i>PUBLIC</i>	0.21	2.30**
<i>BHC</i>	0.07	1.40
<i>HHI</i>	-0.83	-3.18***
<i>CRI</i>	-1.28	-3.61***
<i>R</i> ²	0.26	

This table presents the estimation results of the baseline regression model (Eq. 1). The dependent variable is denoted by *CAMELS* and is a composite vector of capital strength (*CAPI*), asset quality (*ASSETQLTI*), quality of management (*MNGEXPI*), earnings strength (*EARNI*), degree of liquidity (*LQDTI*), and sensitivity to market risk (*SENSRISKI*). The key dependent variables are the GDP output gap (*GDP*), the inflation rate (*CPI*), the unemployment rate (*UNEM*), market return volatility (*VIX*), market liquidity risk (*MRKLQDT*), and the market credit risk (*MRKCREDIT*). The set of control variables includes bank size groups (small, medium, large, and extra-large

banks), a dummy for acquirer banks in M&A transactions (*MA*), a dummy showing whether a bank is located in a MSA or in a rural county (*MSA*), a dummy for newly-chartered banks (*DENOV*); a dummy variable for banks which are listed on the stock exchange (*PUBLIC*), a dummy indicating whether a bank is a subsidiary of a BHC (*BHC*), banking market concentration (*HHI*), and a dummy variable that captures the crisis period (*CRI*). All observations are based on quarter observations, and cover the entire data period, which extends from 2002q1 to 2015q4. The description of each variable and the relevant data sources are included in Appendix A.

***, **, * correspond to 1%, 5%, and 10% level of significance respectively for a two-tailed distribution

Our results reveal the large extent to which bank regulatory ratings depend on business cycle fluctuations: the coefficient of GDP growth as well as that of inflation turn out to be significantly positive at the 1% level, while the coefficient of unemployment is significantly negative also at the 1%. This implies that *CAMELS* increase during cyclical upturns and decrease during downturns. The effects of economic conditions we document here are in line with the effects obtained from our baseline regression analysis if financial conditions are considered. Lower market volatility (*VIX*), lower liquidity market risk (*MRKLQDT*), and lower market credit risk (*MRKCREDIT*) which are all evidence of stable financial conditions observed during economic upturns are negatively related with bank ratings.

As regards bank size, this is positively linked to *CAMELS* revealing that larger banks are rated higher by regulators. When a bank is involved as an acquirer in a M&A transaction (*MA*), this has a positive and significant impact on its regulatory rating. Further, if a sample bank is located in an MSA, then it is more likely to obtain a higher rating by regulatory authorities. As expected, newly-chartered banks (*DENOV*) are more likely to receive a lower rating, whereas banks which are publically traded (*PUBLIC*) are linked to higher ratings. On the other hand, *BHC* is not found to be significantly related with *CAMELS*. To continue, market concentration (*HHI*) has a negative positive impact on *CAMELS*, implying that banks which operate under a less concentrated (more competitive) market structure are expected to receive a higher rating. Lastly, the impact of the global financial crisis on bank ratings is negative and highly significant.

4. Robustness analysis

We now move to examine the sensitivity of our baseline regression results. To this end, we use a set of alternative variables to construct CAMELS ratings. The main reason of doing so is because the components of CAMELS are kept confidential from regulators and, hence, it is crucial to test the sensitivity of our baseline regression results to a set of alternative CAMELS variables. Capital adequacy is measured by the ratio of Tier 1 regulatory capital to total risk-weighted assets (*CAP2*); asset quality is captured by the restructured and outstanding balances of loans and lease financing receivables that the bank has placed in nonaccrual status divided by total loans and leases (*ASSETQLT2*); management expertise is proxied by the total operating income calculated by the sum of interest income and non-interest income as a fraction of the total earning assets (*MNGEXP2*) which is a typical measure of operating efficiency in the banking literature (see, e.g., Lane et al., 1986); the return on equity given by the ratio of total net income to total equity capital is utilised to measure banks' earnings (*EARN2*); the ratio of federal funds purchased and securities sold under agreements to repurchase to total assets (*LQDT2*) is employed to measure the degree of liquidity of the sample banking firms; and the sensitivity to market risk (*SENSRISK2*) is proxied by the market interest rate risk defined as the quarterly standard deviation of the day-to-day 3-month U.S. T-bill rate divided by total earning assets. All variables employed in the robustness analysis as well as the sources used to construct these variables are summarised in Appendix A.

We rerun our baseline model (eq. 1) and we obtain the results which are reported in Table 2 and which corroborate our conclusions reached in our baseline analysis. Indeed, we document a statistically significant relationship between *CAMELS* and the overall state of the U.S. economy. In specific, the coefficients of *GDP* and *CPI* are significantly positive at the 1% level, while that of *UNEM* is found to be significantly negative at the 1%, implying that the performance of banks is rated higher when economic conditions are favourable, and lower when the economic environment is weak. Along the same lines, favourable (adverse) financial conditions have a positive (negative) impact on CAMELS.

Table 2
Estimation results: Robustness model

<i>Variable</i>	Coeff. value	<i>t</i> -stat
<i>GDP</i>	0.20	3.18***
<i>CPI</i>	0.21	3.06***
<i>UNEM</i>	-0.12	-2.72***
<i>VIX</i>	-0.18	-4.01***
<i>MRKLQDT</i>	-0.23	-2.38**
<i>MRKCREDIT</i>	-0.11	-1.97**
<i>SIZE</i>	0.45	2.37**
<i>MA</i>	0.26	2.50**
<i>MSA</i>	0.05	2.08**
<i>DENOVO</i>	-0.20	-1.88*
<i>PUBLIC</i>	0.17	2.41**
<i>BHC</i>	0.09	1.27
<i>HHI</i>	-0.71	-3.58***
<i>CRI</i>	-1.13	-3.90***
<i>R</i> ²	0.28	

This table presents the estimation results of the baseline regression model (Eq. 1). The dependent variable is denoted by *CAMELS* and is a composite vector of capital strength (*CAP2*), asset quality (*ASSETQLT2*), quality of management (*MNGEXP2*), earnings strength (*EARN2*), degree of liquidity (*LQDT2*), and sensitivity to market risk (*SENSRISK2*). The key dependent variables are the GDP output gap (*GDP*), the inflation rate (*CPI*), the unemployment rate (*UNEM*), market return volatility (*VIX*), market liquidity risk (*MRKLQDT*), and the market credit

risk (*MRKCREDIT*). The set of control variables includes bank size groups (small, medium, large, and extra-large banks), a dummy for acquirer banks in M&A transactions (*MA*), a dummy showing whether a bank is located in a MSA or in a rural county (*MSA*), a dummy for newly-chartered banks (*DENOV*); a dummy variable for banks which are listed on the stock exchange (*PUBLIC*), a dummy indicating whether a bank is a subsidiary of a BHC (*BHC*), banking market concentration (*HHI*), and a dummy variable that captures the crisis period (*CRI*). All observations are based on quarter observations, and cover the entire data period, which extends from 2002q1 to 2015q4. The description of each variable and the relevant data sources are included in Appendix A.

***, **, * correspond to 1%, 5%, and 10% level of significance respectively for a two-tailed distribution

5. Concluding remarks

The financial crisis which erupted in 2007-8 has illustrated the disruptive effects of procyclicality, which refers to the amplification of the effects of the business cycle, and of the risk that can build up when financial institutions acting in an individually imprudent manner collectively create systemic problems. There is now broad consensus among regulators and supervisors that the microprudential regulatory framework needs to be complemented by macroprudential principles that can smooth the effects of the credit cycle. This has led to proposals for countercyclical capital requirements and loan loss provisions that would be higher in good times and lower in bad times.

One very important aspect which should also be seriously considered from authorities is the procyclicality of performance ratings system of banking institutions, which is the main topic of analysis of the current study. Indeed, in this study, we focus on the ratings of the U.S. banking institutions and how these are linked to the phenomenon of procyclicality. Towards this, we empirically investigate the sensitivity of CAMELS ratings system, which is used by the U.S. authorities to monitor the conditions in the banking market, to the fluctuations of economic cycle. The results of our empirical analysis reveal that the overall state of the U.S. economy and CAMELS ratings largely depend on the course of the business cycle. More concretely, we find that CAMELS are lower during economic upturns and higher during economic downturns. This is to say that the performance and risk-taking behaviour of banks is rated higher when the conditions in the economy are favourable, and lower when the economic environment turns to be weak.

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Appendix A: Variables and data sources

The following table presents all variables that we use in the econometric analysis. The abbreviation of each variable and the source we use to collect the data are also reported.

Variable	Abbreviation	Definition	Data source
<i>CAMELS components</i>			
Capital adequacy	<i>CAP1</i>	The ratio of book equity capital to total assets	Call Reports
	<i>CAP2</i>	The ratio of regulatory (Tier 1) capital to total risk-weighted assets	
Asset quality	<i>ASSETQLT1</i>	The ratio of non-performing loans to total loans and leases	
	<i>ASSETQLT2</i>	The ratio of restructured and outstanding balances of loans and lease financing receivables that the bank has placed in nonaccrual status to total loans and leases	
Management expertise	<i>MNGEXP1</i>	Managerial efficiency calculated using the input-oriented DEA model	
	<i>MNGEXP2</i>	The ratio of total operating income calculated as the sum of interest income and non-interest income to total earning assets	
Earnings strength	<i>EARN1</i>	The ratio of total net income given by the difference between total interest plus non-interest income and total interest plus non-interest expense to total assets	
	<i>EARN2</i>	The ratio of total net income given by the difference between total interest plus non-interest income and total interest plus non-interest expense to total equity capital	
Liquidity	<i>LQDT1</i>	The ratio of cash and balances due from depository institutions to total deposits	
	<i>LQDT2</i>	The ratio of federal funds purchased and securities sold under agreements to repurchase to total assets	
Sensitivity to market risk	<i>SENSRISK1</i>	The change in the slope of the yield curve (given by the change in the quarterly difference between the 10-year U.S. T-bill rate and the 3-month U.S. T-bill rate) divided by total earning assets.	Federal Reserve Board & U.S. Department of the Treasury
	<i>SENSRISK2</i>	Market interest rate risk (defined as the quarterly standard deviation of the day-to-day 3-month U.S. T-bill rate) divided by total earning assets.	

Managerial efficiency

Total loans	<i>u1</i>	The sum of commercial, construction, industrial, individual and real estate loans	
Total deposits	<i>u2</i>	The sum of total transaction deposit accounts, non-transaction savings deposits, and total time deposits	
Other earning assets	<i>u3</i>	The sum of income-earned assets other than loans and the net deferred income taxes	
Total non-interest income	<i>u4</i>	The sum of income from fiduciary activities, service charges on deposit accounts, trading fees and income from foreign exchange transactions and from assets held in trading accounts, and other non-interest income	
Securitisation activity	<i>u5</i>	The value of the outstanding principal balance of loans, leases, and all relevant assets securitised and sold to other financial institutions with recourse or other credit enhancements divided by total assets	Call Reports
Price of borrowed funds	<i>v1</i>	The ratio of total interest expense to total deposits and other borrowed money	
Price of labour	<i>v2</i>	The ratio of total salaries and benefits to the number of full-time employees	
Price of physical capital	<i>v3</i>	The ratio of expenses for premises and fixed assets to the dollar amount of premises and fixed assets	

Macroeconomic conditions

Economic growth	<i>GDP</i>	GDP output gap	Bureau of Economic Analysis, U.S. Department
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of Commerce

Inflation	<i>CPI</i>	The quarterly change in U.S. Consumer Price Index (CPI)	Bureau of Labor Statistics,
Unemployment	<i>UNEM</i>	Unemployment rate	U.S. Department of Labor
<i>Financial conditions</i>			
Implied Volatility	<i>VIX</i>	An index of market return volatility	Chicago Board Options Exchange Market
Market liquidity risk	<i>MRKLQDT</i>	The quarterly difference between the 3-month LIBOR rate and the 3-month U.S. T-bill rate	Federal Reserve Board & GFDatabase
Market credit risk	<i>MRKCREDIT</i>	The quarterly change in the credit spread between the 10-year BAA-rated bonds and the 10-year U.S. T-bill rate	Federal Reserve Board & Moody's
<i>Control variables</i>			
Bank size	<i>SIZE</i>	The book value of the logarithm of total assets	Call Reports
M&A transactions	<i>MA</i>	A dummy which is equal to unity if a bank is involved in a M&A transaction as an acquirer	M&As database/Federal Reserve Bank of Chicago
Banking market concentration	<i>HHI</i>	The sum of squares of the market share of each sample bank	Call Reports
Bank location	<i>MSA</i>	A dummy showing whether a bank is located in a Metropolitan Statistical Area or not	Call Reports & U.S. Office of Management and Budget
Newly-chartered bank	<i>DENOVO</i>	A dummy capturing the banks which are less than five years old	Call Reports
Listed bank	<i>PUBLIC</i>	A dummy which is equal to unity if bank i is listed on the exchange market	Call Reports & Center for Research in Security Prices (CRSP)
BHC affiliation	<i>BHC</i>	A dummy variable indicating whether a sample bank is a subsidiary of some BHC	Call Reports
Crisis dummy	<i>CR1</i>	A dummy which is equal to 1 in 2007q3	

Appendix B

To calculate managerial efficiency (*MNGEXP1*), we employ the Data Envelopment Analysis (DEA) model. DEA model can be computed either as input- or output-oriented. The input-oriented DEA model shows by how much input quantities can be reduced without varying the output quantities produced. Similarly, the output-oriented DEA model assesses by how much output quantities can be proportionally increased without changing the input quantities used. Both output- and input-oriented models identify the same set of efficient/inefficient bank management. Nevertheless, even though the two approaches provide the same results under constant returns to scale, they give different values under variable returns to scale.⁶

We assume that for the N sample banks, there exist P inputs producing M outputs. Hence, each bank i uses a nonnegative vector of inputs denoted by $v^i = (v_1^i, v_2^i, \dots, v_p^i) \in R_+^P$ to produce a nonnegative vector of outputs, denoted by $u^i = (u_1^i, u_2^i, \dots, u_m^i) \in R_+^M$, where: $i = 1, 2, \dots, N$; $p = 1, 2, \dots, P$; and, $m = 1, 2, \dots, M$. The production technology, $F = \{(u, v): v \text{ can produce } u\}$, describes the set of feasible input-output vectors. The input sets of production technology, $L(y) = \{v: (u, v) \in F\}$, describe the sets of input vectors which are feasible for each output vector.

To measure the variable returns to scale managerial cost efficiency (*MNGEXP1*), we resort to the following input-oriented DEA model, where inputs are minimised and outputs are held at constant levels. Below, we sketch out the optimisation (minimisation) problem of bank₁'s ($i=1$) cost inefficiency. Note that each bank i faces the same optimisation problem.

$$MNGEXP1_1^* = \min(-MNGEXP1_1), \text{ s.t. } \sum_{i=1}^N \lambda_i v_{ip} \leq (MNGEXP1_1)(v_{1p}) \quad (B1)$$

$$\sum_{i=1}^N \lambda_i u_{im} \geq u_{1m} \quad (B2)$$

$$\sum_{i=1}^N \lambda_i = 1 \quad (B3)$$

$$\lambda_i \geq 0 \quad (B4)$$

In Eq. (B1- B4), v_{1p} and u_{1m} are the p th input and m th output for bank₁, respectively; the convexity constraint, $\sum_{i=1}^N \lambda_i = 1$, accounts for variable returns to scale, where λ_i stands for the activity vector and denotes the intensity levels at which the total observations are conducted.

⁶ For a detailed discussion on the differences between input- and output-oriented DEA models, the interested reader can refer to Coelli et al. (2005).

This approach, through the convexity constraint, forms a convex hull of intersecting planes, since the frontier production plane is defined by combining a set of actual production planes. If $MNGEXP1_1^*$ is equal to unity, then the optimal efficiency score is achieved for bank₁. This shows that the levels of inputs used cannot be proportionally improved given the output levels, indicating that bank₁ lies upon the cost efficiency frontier. If, on the other hand, $MNGEXP1_1$ is less than unity the management of bank₁ is considered to be inefficient. The more $MNGEXP1_1$ deviates from the unity, the less efficient the management of bank₁ becomes.

An important concern in the estimation of *MNGEXP1* is the definition of inputs and outputs. This essentially depends on the specific role that deposits play in the overall business model of banks. The relevant literature addresses this issue by traditionally referring to two approaches: the intermediation (or asset) approach, and the production (or value-added) approach.⁷ Under the former approach, financial firms are viewed as intermediaries which transform deposits and purchased funds into loans and other earning assets. That is, liabilities and physical factors are treated as inputs, while assets are treated as outputs. The production approach, on the other hand, regards financial institutions as producers of services for account holders, measuring output with the number of transactions or documents processed over a given period of time. Therefore, deposits are encompassed in the output and not in the input vector, which exclusively consists of physical entities.

Berger and Humphrey (1991) proposed a third approach, the modified production approach, which, contrary to the aforementioned traditional approaches, captures the dual role of bank deposits. This third approach is regarded as a combination of the intermediation and production approaches, as it enables the consideration of both the input and output characteristics of deposits in the cost function. More specifically, the price of deposits is considered to be an input, whereas the volume of deposits is accounted as an output. Under this specification, banks are assumed to provide intermediation and loan services as well as payment, liquidity, and safekeeping services at the same time. Hence, it can be argued that the latter approach describes the key bank activity of deposit-taking in a more complete manner thereby providing a closer representation of reality.

We adopt the modified production approach to define inputs and outputs in the estimation of *MNGEXP1*. We specify five variable outputs in total of which traditional banking activities are

⁷ See Berger and Humphrey (1997) for a detailed analysis of the advantages and disadvantages of each of the two approaches.

captured by three outputs, namely, total loans (u_1) calculated as the sum of commercial, construction, industrial, individual and real estate loans; total deposits (u_2) which is the sum of total transaction deposit accounts, non-transaction savings deposits, and total time deposits; and, other earning assets (u_3), expressed as the sum of income-earned assets other than loans and the net deferred income taxes. Non-traditional banking activities are proxied by two outputs: total non-interest income (u_4), which is the sum of income from fiduciary activities, service charges on deposit accounts, trading fees and income from foreign exchange transactions and from assets held in trading accounts augmented by any other non-interest income; and, securitisation activity (u_5) measured as the value of the outstanding principal balance of loans, leases, and all relevant assets securitised and sold to other financial institutions with recourse or other credit enhancements divided by total assets.

Regarding the inputs we employ in the estimation of *MNGEXPI*, we consider borrowed funds, labour, and physical capital. The price of borrowed funds (v_1) is defined as the ratio of total interest expense scaled by total deposits and other borrowed money; the price of labour (v_2) is calculated by dividing total salaries and benefits by the number of full-time employees; and, lastly, the price of physical capital (v_3), which is equal to the expenses for premises and fixed assets divided by the dollar amount of premises and fixed assets.